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(54) Title: METHOD FOR PURIFYING THE WATER

(57) Abstract

The invention discloses a method for purification of the water corresponding to the "drinking" classification. The method includes the following stages: a determination of the impurities being decomposed by the ozone; a preliminary purification; a first ozonization; an electrocoagulation; a second ozonization; and a finish purification. The ozone is generated in an amount exceeding the necessary amount not more than for 7%.

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METHOD FOR PURIFYING THE WATER

Field of the invention

The invention relates to the water purification field, namely to the reagent-free water preparation field, and can be used in supplying customers with a drinkable water, which customers are located in temporary residence places or places not requiring significant water flow, particularly objects of the small town planning, and also the invention can be useful in extreme conditions, particularly in sudden disconnecting the customer from the water-supply line.

Background of the invention

At present, almost all techniques of the water purification up to the «drinking water» classification include the following operations of: taking a water from natural reservoirs (rivers and lakes), settling the water with passing it through hydraulically deposed sand filters, passing the water through different assemblies (modules) purifying the water from organic and inorganic impurities, and also from pathogenic micro-organisms. In this case, different chemical reagents are utilised sufficiently wide, particularly chlorine and fluorine. When employing the artesian wells as the water source, it is also necessary to purify the water from organic and inorganic impurities. When employing the sea water as the initial one, a considerable amount of the energy for desalinating the water is consumed in addition to the consumption of reagents.

Methods and equipment of both the industrial scale and local consumption for preparing the water are substantially similar. Therefore, the cost price

of the water purification in the local consumption is considerably higher than the cost price of the water purification in the industrial scale since, with substantially similar expenditures, the productivity of industrial plants is much higher. So, in order to reduce the cost price of the local water purification, the production is simplified at the cost of excluding some production stages, and also decreasing the reagent consumption. All this brings inevitably to the quality deterioration of the purified water.

The more prospective trend of the water purification is the reagent-free purification of the initial water.

The reagent-free water purification is known for a rather long time. The usage of electrical fields in extracting different ions, and also in annihilating the pathogenic bacteria is employed sufficiently wide in various technical fields, and also in the medicine. However, known methods and apparatus do not allow to eliminate the organic impurities, and furthermore, they are power-intensive and require using the high voltage, which prevents from their wide application.

A water purification by means of its ozonization is also known. However, this method also was not widely practised because of the ozone destructive effect on equipment materials, and also on micro-organism consortia allowing to perform the biologic water purification. Therewith, at present, the reagent-free water purification using the ozonization is the most preferable trend since in its realisation it is not necessary to use any reagents, and the ozone not utilised during the water purification is decomposed spontaneously without polluting the environment.

In particular, a module plant for the water purification is known (RU patent [1] 2096342, Int.Cl. C 02 F 1/78, 1997), comprising a preliminary purification module, an ozonization module made in the form of a first and second ozonization columns, an electro-coagulation module connected between the

ozonization columns, a finish purification module including a fine filtration assembly and an UV-reactor, and a power module. The module realisation of the plant permits to transport it easily, if necessary, which makes the plant useful for deploying it in temporary settlements. When employing this plant, an initial water is preliminarily purified using the preliminary purification module that comprises usually a hydrocyclone and/or a rough purification filter. The preliminarily purified water is ozonized in two stages, between which the water is treated by the electrocoagulation, and after the second ozonization stage the salts are removed from the water with the consequent finish purification and UV-disinfection. Although the water suitable for drinking is obtained in the result, the process cannot be considered as optimal, because the water purification by micro-organisms bringing to an improvement of a quality of the obtained water is substantially completely excluded. The usage of two ozonization stages without limiting an amount of a generated ozone and without taking into account a composition and amount of impurities brings to an increase of the ozone content in the environment being purified after the ozonization columns and, respectively, to the death of micro-organisms in the equipment including the fine purification filter. Although, in the description text and in the dependent claims, there is an indication onto boundaries of used ozone concentrations in both ozonization columns, and also onto an operation of destroying the ozone that did not react after the second ozonization stage, and also onto the micro-organism involvement in the water purification process, nevertheless it had been found out during the usage that, at an insignificant amount of impurities and a little ozone consumption caused by them, micro-organisms in equipment modules are lost substantially completely and take no part in the water purification. Furthermore, a significant ozone influence at the equipment occurs in this case, which shortens an equipment lifetime and, consequently, a cost price of the water being purified.

Summary of the invention

An object of the present invention is to develop a reagent-free method for purifying the water, which allows to improve the quality of the obtained water.

Another object of the present invention is to increase an operation life of the used equipment.

Yet another object of the present invention is to decrease the cost price of the purified water.

In order to attain these objects it is proposed: to evaluate preliminarily a content of impurities being decomposed by the ozone in the water being purified; then to take the water being purified into the preliminary purification module; to perform a preliminary purification of the water with removing the rough dispersed impurities and suspended particles from the water, a first ozonization stage, an electrocoagulation with removing the organic impurities, a second ozonization stage, a water demineralisation, a fine filtering of the water and an UV-sterilisation of the purified water, therewith in the first and second ozonizations an amount of the ozone supplied into the water being purified must not exceed an amount of the ozone needed for purification process more than for 7 %, and in a stage of a finish water purification a micro-organism consortium is employed which comprises micro-organisms inherent to a given locality and which is disposed in a finish purification module. After the electrocoagulation stage the water can be purified additionally by filtering. For this purpose it is desirable to use a filter having a floating charge, on which the micro-organism consortium comprising the micro-organisms inherent for the water taking point can be disposed. Materials having the positive buoyancy, particularly the silica gel and/or activated carbon can be employed

as the floating charge. After the second ozonization stage the water can be gathered in a tank-accumulator. In the stage of the preliminary purification the water is preferably passed through a hydrocyclone and/or rough purification filter. It is preferably to employ a set of metal meshes as the rough purification filter, to which meshes a voltage can be supplied creating an electric field repelling the impurity elements. The taking of the water for the purification, and also the moving of the water along the purification system are preferably performed by pumps. A set of micromodules of hollow fibers with the micro-organism consortium disposed on their inner surface is preferably employed as the fine purification filters.

During the purification the water comes to the preliminary purification stage in which a separation of the rough dispersed impurities and suspended particles of size more than 5 micrometers takes place. Then, in the first ozonization stage, an annihilation of microalgea, partial oxidation of the organic impurities, and oxidation of ions of metals with variable valence to higher oxidation degrees take place. The ozonized water comes to the electrocoagulation stage where the electrocoagulation of the organic impurities takes place. In using the filtering with the floating charge, the coagulated organic impurities are separated, and the additional water purification is performed by the micro-organism consortium. In the second ozonization stage, an extra oxidation of the organic impurities and substantially complete annihilation of the pathogenic micro-organisms take place. In the subsequent demineralisation stage, hardness salts and ferrous salts are removed. The fine filtration removes all impurities turned into the insoluble state in previous stages, and also performs an additional water purification from residual inorganic and organic impurities by means of the micro-organism consortium. The finish UV-sterilisation purifies the water from micro-organisms of the consortium.

Brief description of drawings

The drawing shows a diagram of the module assembly preferably employed in the method embodiment.

The module assembly comprises an immersion pump 1, a hydrocyclone 2, a rough purification filter 3, a first ozonization column 4 with an ozone generator 5, an electrocoagulation module 6, a filtration module 7 with the floating charge, a second ozonization column 8 with an ozone generator 9 and an ozone destructor 10, a tank-accumulator 11, a pump 12, a demineralisation module 13, a fine purification filter 14, an UV-reactor 15 and a power module 16. The immersion pump 1, hydrocyclone 2, and rough purification filter 3 are members of a preliminary purification module 17. The first ozonization column 4, second ozonization column 8, ozone generators 5 and 9, and also the ozone destructor 10 are members of an ozonization module 18. The finish purification filter 14 and UV-reactor 15 form a finish purification module 19. The power module 16 is connected electrically to pumps 1 and 12, ozone generators 5 and 9, ozone destructor 10, modules 6 and 13, and UV-reactor 15.

It is preferable to employ electrolyzers, preferably with inert electrodes, as the electrocoagulation module and demineralisation module. A Diesel-generator plant or a power line can be utilised as the power module. It is preferable to use electrolyzers and UV-reactor, which are made with a possibility to vary the operation modes.

Preferred embodiment of the invention

First, a content of impurities being removed using the ozone is determined in a water to be purified. With regard to the performed measurements, a necessary ozone concentration is determined, which has to be generated in the first and second ozonization columns.

The water being purified from the source (an open reservoir or artesian bore) is supplied by means of the pump 1 to the hydrocyclone 2, where a separation of suspended particles having sizes more than 5 micrometers, and rough dispersed impurities take place. After the hydrocyclone 2 the water comes to the rough purification filter 3, where a separation of insoluble impurities takes place, and in the case of employing the metal meshes and supplying an electrical potential on them, metal ions are partially removed. The ozone having the concentration of about 0.001 kg/m^3 determined at the first stage is introduced into the thus purified water in the first ozonization column 4. In so doing, pathogenic micro-organisms and microalgea are annihilated, metal ions are oxidised to higher oxidation degrees, and organic compounds present in the water are partially oxidised. The water having residual amount of the ozone comes from the ozonization column 4 into the electrocoagulation module 6, where colloid organic compounds are coagulated. A presence of residual amount of the ozone intensifies the coagulation process. In moving the water being purified from the column 4 to the module 7 the ozone is spontaneously dissociated, and the water come to the module 7 does not substantially comprises the ozone. This results in appearing the micro-organism consortium on the floating charge as which an activated carbon is utilised. The consortium can be introduced on the floating charge artificially, or it can be extracted during the assembly operation. The floating charge stops the coagulated organic compounds substantially completely. In the second ozonization column 8 the ozone having the concentration of 0.0013 kg/m^3 determined at the first stage is introduced into the water being purified, and therewith the extra oxidation of the organic impurities and complete annihilation of the pathogenic micro-organisms and micro-organisms of the consortium disposed on the floating charge take place. Where possible, at the output of the column 8 the management of the residual ozone concentration is performed. In the event

that the concentration is sufficiently high and can bring to the death of the micro-organism consortium disposed in the finish purification module 19, then the dissociation of the ozone surplus is performed using the ozone destructor 10. In the second ozonization stage the oxidation of the residual organic impurities takes place. The water substantially purified from the organic impurities comes to the demineralisation module 13. The demineralisation module removes substantially completely the hardness salts and compounds of the iron group. After the demineralisation module 13 the water comes to the finish purification module 19 where the final extracting of the insoluble and soluble impurities to the level corresponding to the drinking water takes place in a mechanical way and by action of the micro-organism consortium. The UV-reactor disposed at the output of the module 19 purifies the water from micro-organisms of the consortium.

The usage of the method allows to produce the drinking water without great capital expenditures and with a low cost price.

Claims

1. A method for purifying the water including: a preliminary purification, a first ozonization stage, an electrocoagulation, a second ozonization stage, and a finish purification, characterised in that a content of impurities being decomposed by the ozone is determined preliminarily, in the first and second ozonization stages an amount of the ozone is generated exceeding the necessary amount not more than for 7 %, at the finish an additional purification by a micro-organism consortium being performed, which comprises the micro-organisms inherent to the given locality and disposed in the finish purification module.

2. The method according to the claim 1, characterised in that after the electrocoagulation stage an additional purification is performed using a filter with a floating charge.

3. The method according to the claim 2, characterised in that the silica gel and/or activated carbon are employed as the floating charge.

4. The method according to the claim 1, characterised in that after the second ozonization stage the water is gathered in a tank-accumulator.

5. The method according to the claim 1, characterised in that in the preliminary purification stage the water is passed through a hydrocyclone and/or rough purification filter.

6. The method according to the claim 1, characterised in that a set of meshes is employed as the rough purification filter.

7. The method according to the claim 1, characterised in that in the finish purification stage the water is passed in series through a fine purification filter comprising the micro-organism consortium, and an UV-reactor.

8. The method according to the claim 7, characterised in that a set of micromodules of hollow fibers is employed as the fine purification filter.

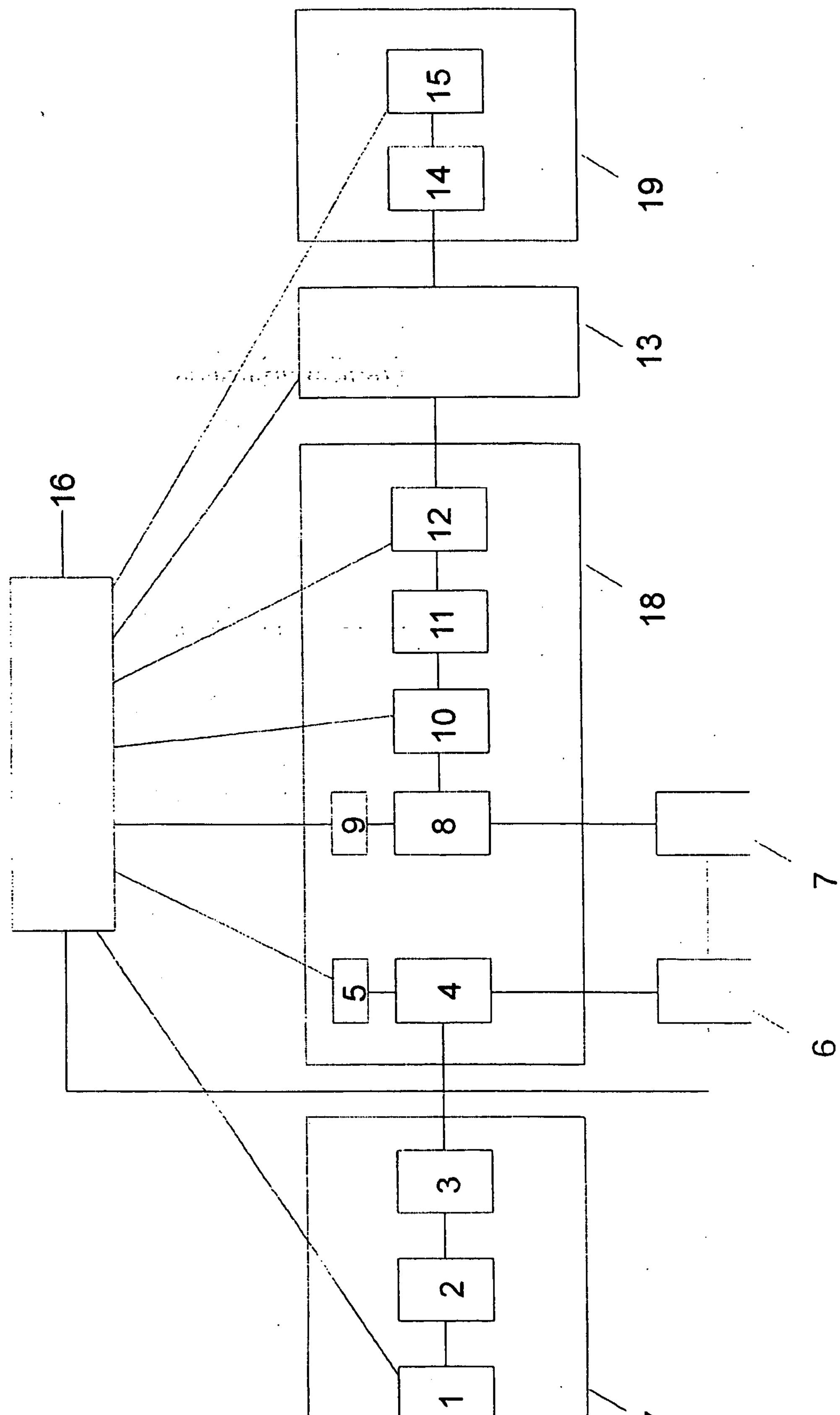

Fig. 1

INTERNATIONAL SEARCH REPORT

Intern. .al Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C02F9/06 C02F1/78

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C02F B03C B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DATABASE WPI Section Ch, Week 199828 Derwent Publications Ltd., London, GB; Class D15, AN 1998-320651 XP002121570 & RU 2 096 342 C (BOGOLITSYN K G), 20 November 1997 (1997-11-20) cited in the application abstract & RU 2 096 342 A (K. G. BOGOLITSYN) 20 November 1997 (1997-11-20) --- -/--	1

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/RU 99/00113

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